

Semi-autonomous Robotics



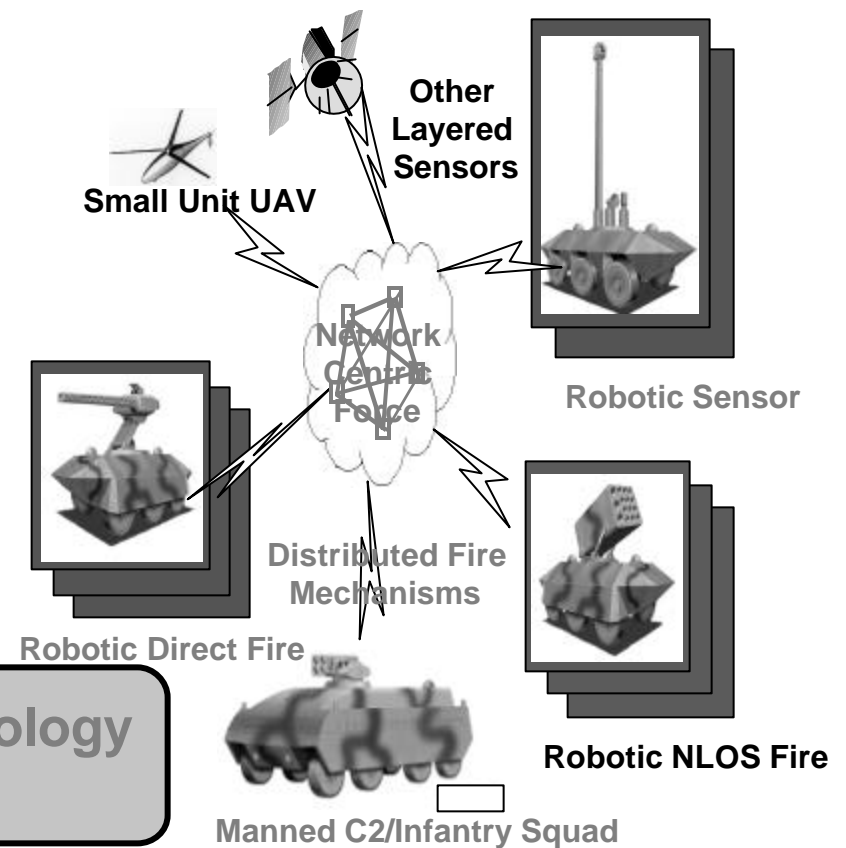
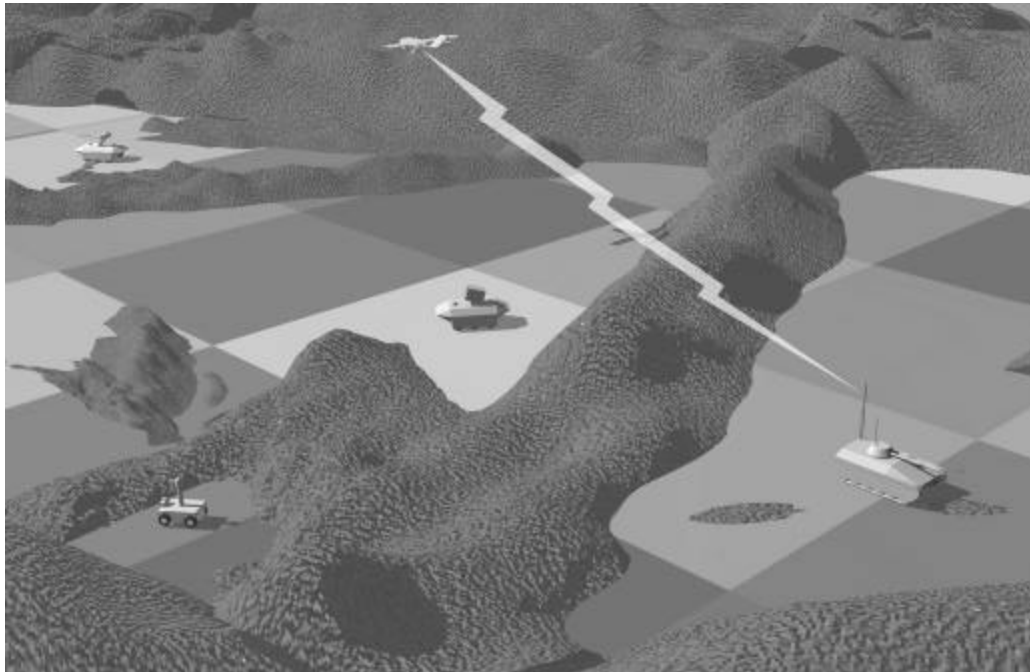
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Semi-Autonomous Robotics



- *Expand the Battlespace*
- *Enhance Force Survivability*
- *Increase Deployability – Reduce Footprint*



**Developing Autonomous Mobility Technology
For Unmanned Ground Vehicles**



Pathway to Advancing Ground Robotics Technology

- Rapidly develop, test, and transition technology
- Substantially increase performance levels
- Focus research
 - perception – intelligent control & behaviors – man-machine-interface
 - small, reliable, modular autonomous mobility technology packages
 - multi-mission, multi-platform application
- Get technology out to the field
 - data collection
 - quantitative engineering tests
 - functional testing with soldiers
- Provide new options for light, deployable and survivable systems
 - Multi-mission capable
 - Acceptable soldier workload



***Early troop experimentation with advanced
robotics technology critical for the Objective Force***



Achieving Autonomous Mobility

- ***Technology Development***

- ***ARL Robotics Collaborative Technology Alliance***

- ***Industrial/academic consortium collaborating with ARL and other Government laboratories***
 - ***Long-term commitment to continued research***

- ***Demo III Program***

- ***Technology development, integration, and field experimentation***
 - ***Demo III XUV Autonomous Mobility Testbeds – the world’s most advanced UGVs for unstructured environments***
 - ***Troop participation in field experiments to focus future research***

- ***Army Programs***

- ***Robotic Follower ATD***

- ***“Lower Risk” approach for autonomous mobility***
 - ***Rapid insertion into future combat systems***
 - ***Technology focus on perception***

- ***Semi-Autonomous Robotics for FCS STO***

- ***Focus on autonomous mobility – application to multiple missions***
 - ***Development of robust tactical behaviors***



DEMO III Unmanned Ground Vehicle Program



**Modeling/Simulation
& Experimentation**

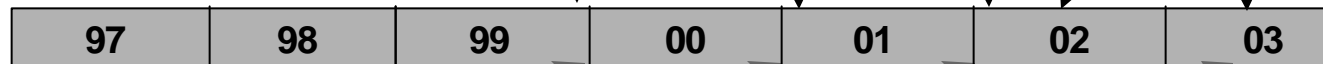
- *Constructive modeling*
- *Virtual Simulations*
- *Live Experimentation*

**Technology
Development**

- *Perception*
- *Intelligent Control*
- *Soldier-Machine Interface*

**Technology
Integration**
RST/SAIC/Sarnoff

FYs



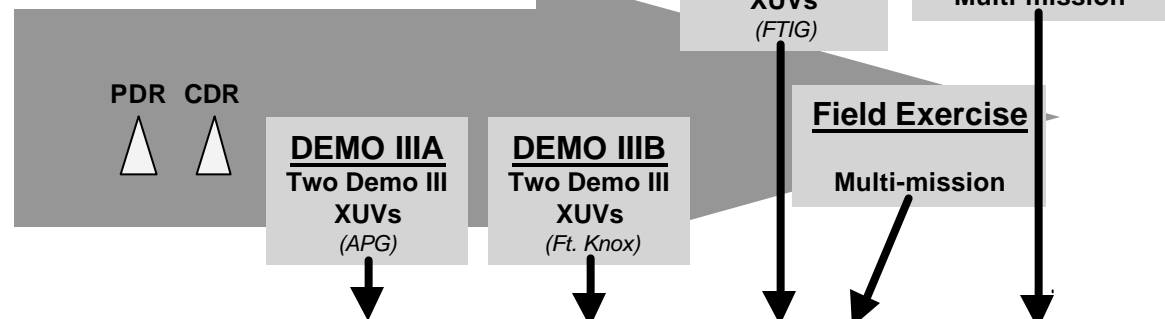
Performance Goals:

*10mph daytime
x-country mobility,
two vehicles*

*20mph daytime
x-country
mobility*

*multi-vehicle
collaborative
operations in
complex terrain,
four vehicles*

*Multi-mission
collaborative
operations*





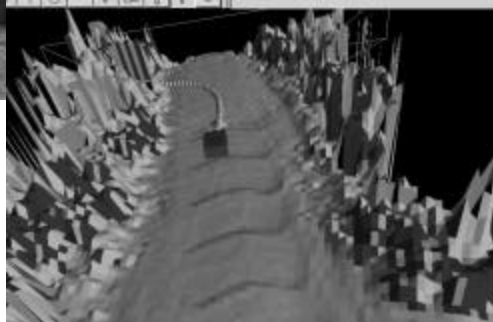
Demo III Technical Activities



Technology Development



- **Sensors**
- **Perception Algorithms**
- **World Model**
- **Planning Algorithms**
- **Soldier-Machine Interface**



Data Collection

Develop new capabilities by getting out into the field to find out what we don't know



Engineering Evaluations

Quantitative System Characterization



Troop Operation & Feedback

Exercise technology with troops on realistic terrain





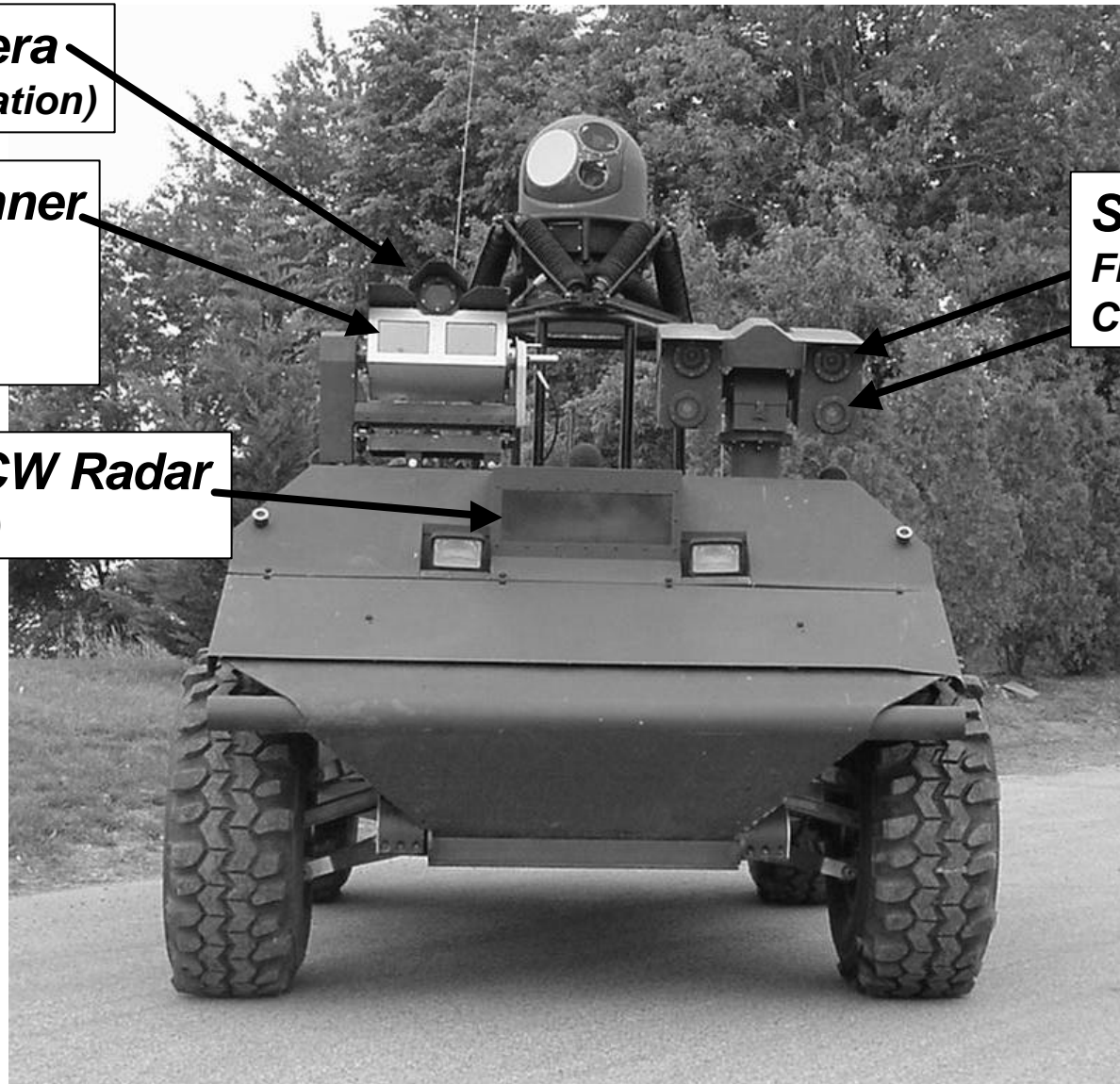
Autonomous Mobility Sensors

Color Camera
(object classification)

Laser Scanner
90° FOV
32 Lines
20 FPS

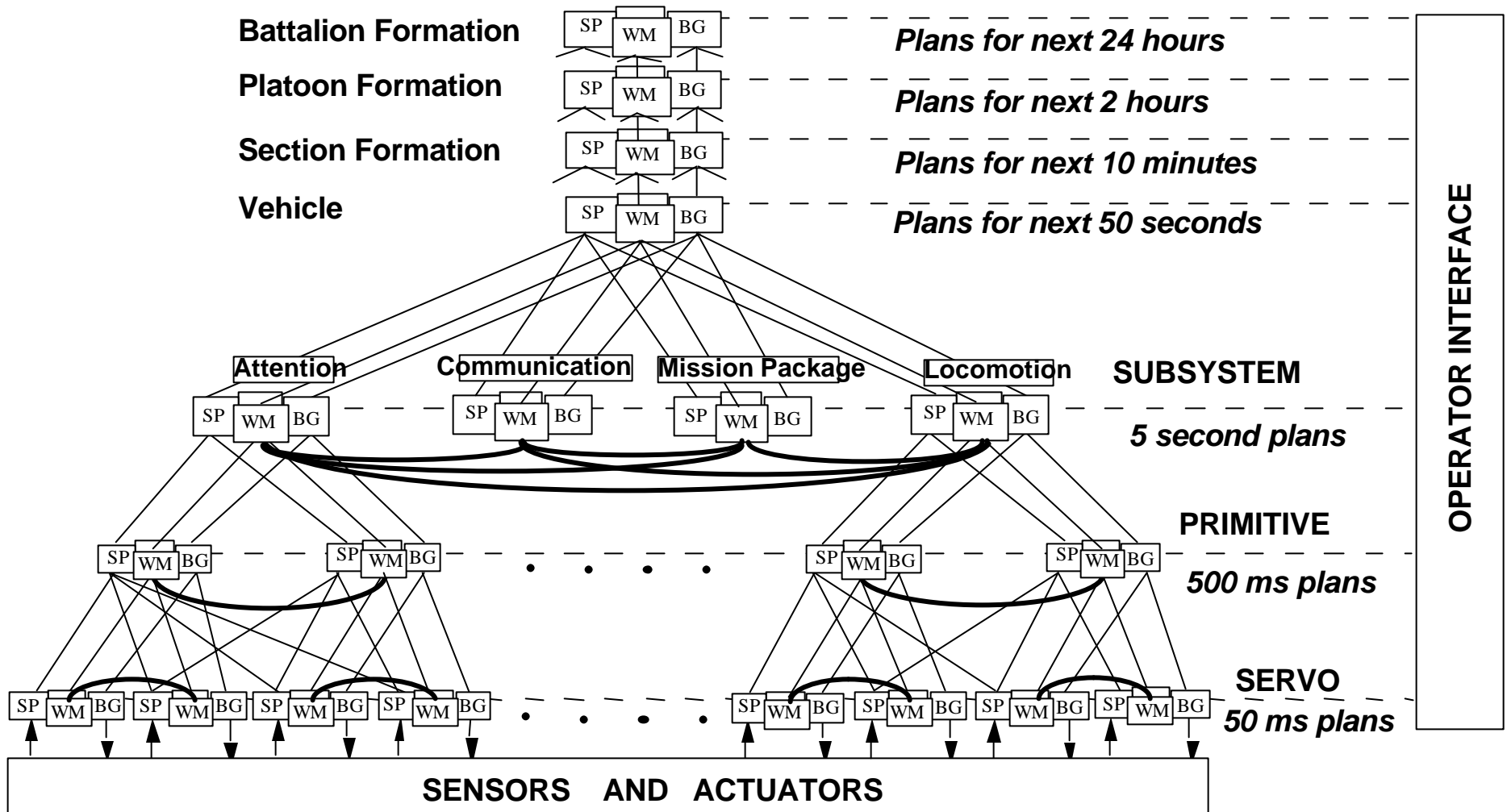
77 GHz FMCW Radar
(Planned)

Stereo Sensors
FLIR – 320 x 256
CCD – 640 x 480





4-D/RCS REFERENCE ARCHITECTURE

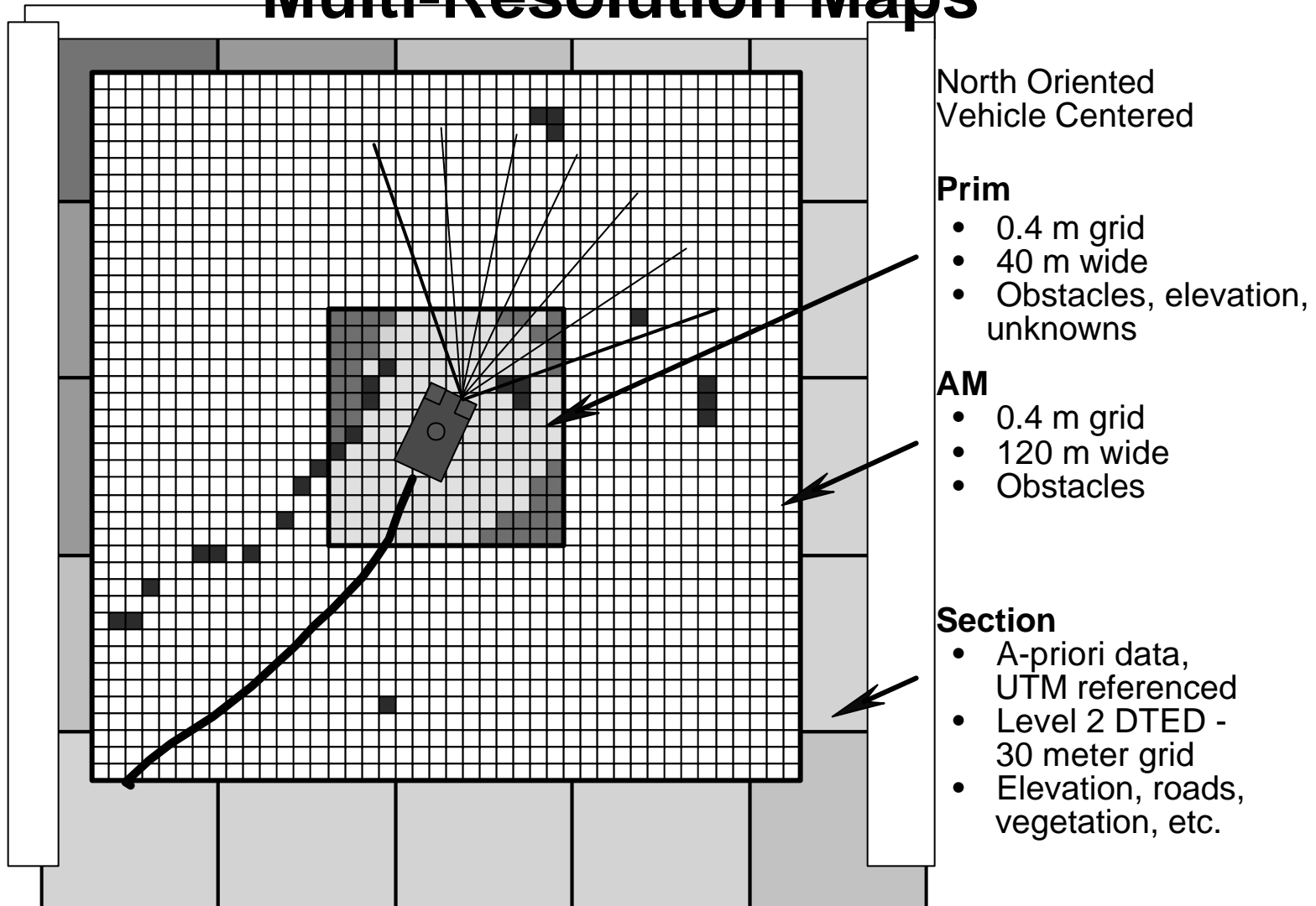




AM World Model – Demo III Bravo



Multi-Resolution Maps

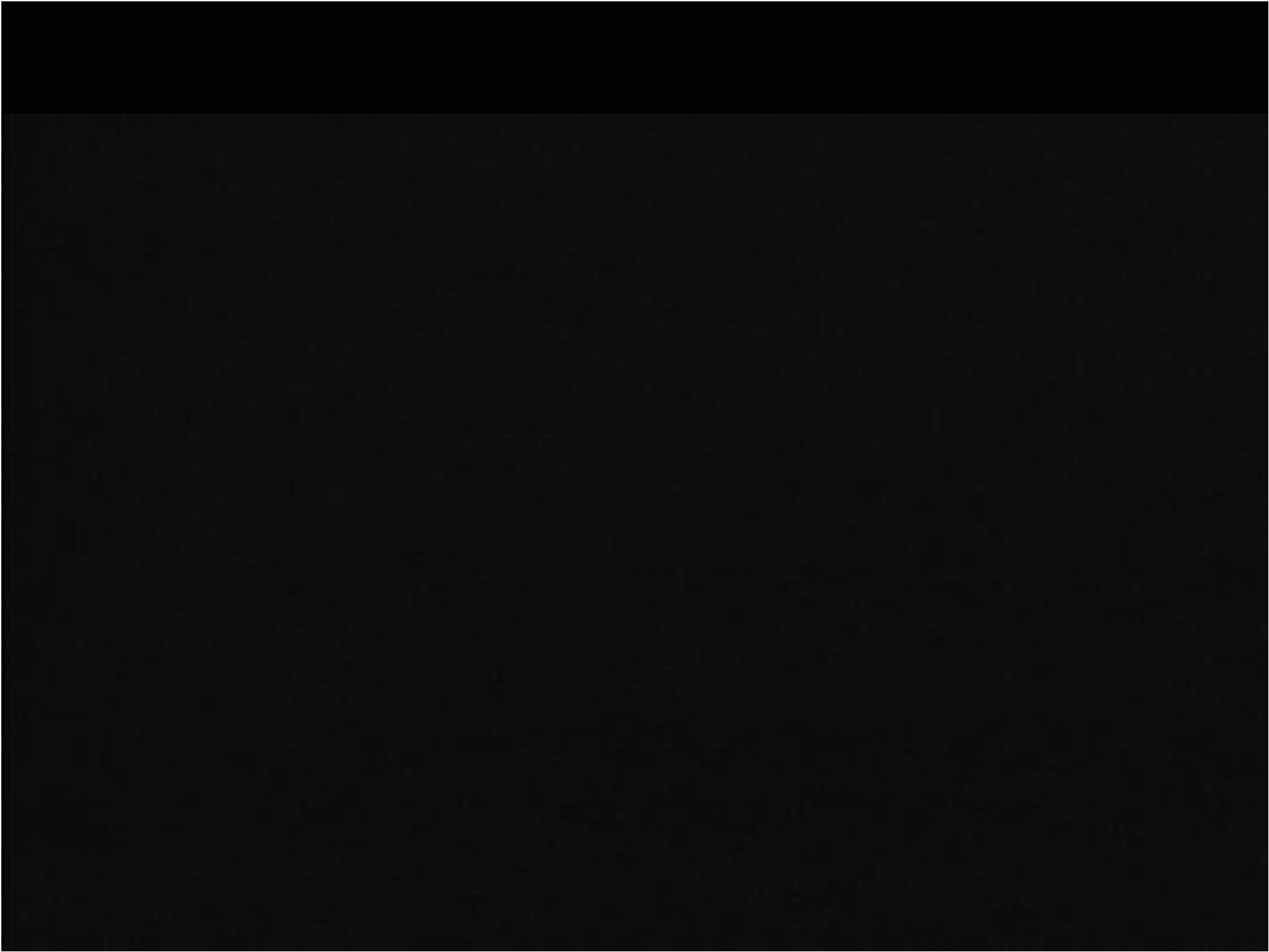




Operator Control Unit

- Single soldier managing multiple vehicles
- DTED level II database employed for planning
- Overlay of cultural & tactical features
- Military symbology
- Automated planning algorithms
- 16" diagonal LCD with NEMA 12 enclosure
- Multi-position swing arm for LCD
- Rugged keyboard
- Electronics box is shock mounted

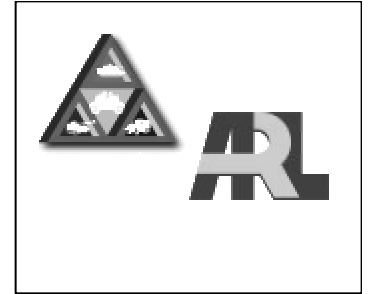






Robotic Follower ATD

(STO III.GC.2000.04)



Lower Risk Ground Mobile Robotics Technology Development Program to Support FCS



Technology Barriers

- ***Perception capabilities***
- ***On-board intelligence for autonomy***

Solution Approach

- ***Manned leader “proofs” path to reduce perception & intelligence requirements***
- ***Rapidly mature & integrate perception technology to enable higher speed & enhanced decision-making capabilities***
- ***Successively demonstrate maturing capability for FCS***

***Mature & Demonstrate Robotics Technology Required for
Early Insertion Into FCS***



Semi-Autonomous Robotics for FCS

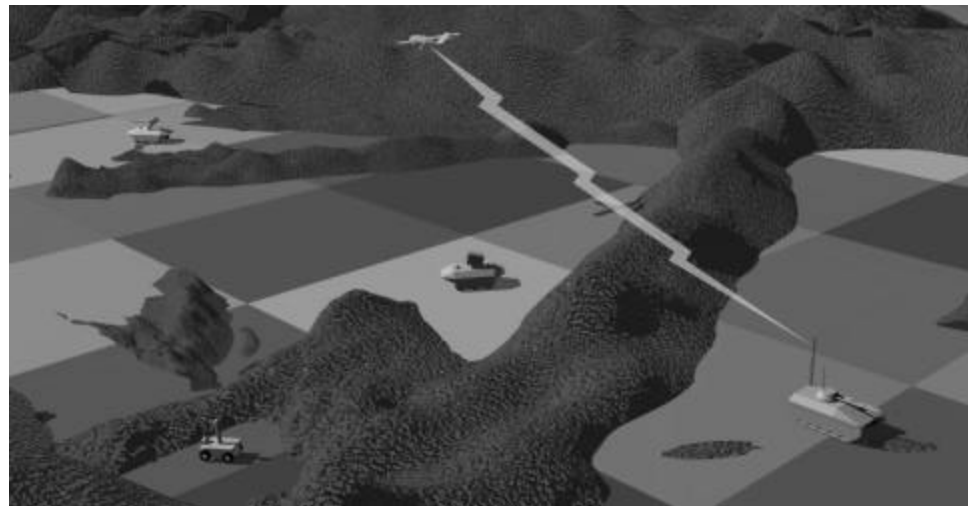
(IV.GC.2001.03)



Objective: Develop the technology required to put unmanned ground vehicles out front, increasing operational reach and enhancing survivability

Program Goals

- Develop baseline “hand-coded” tactical behaviors for “Preceder” missions
- 35/40 MPH day, cross-country mobility for FCS companion scale vehicle – FY05
- Adaptive tactical behaviors for scout mission – FY05



Pacing Technologies

- Perception/Navigation
- Intelligent control/behaviors
- Soldier-machine interface

Warfighter Payoffs

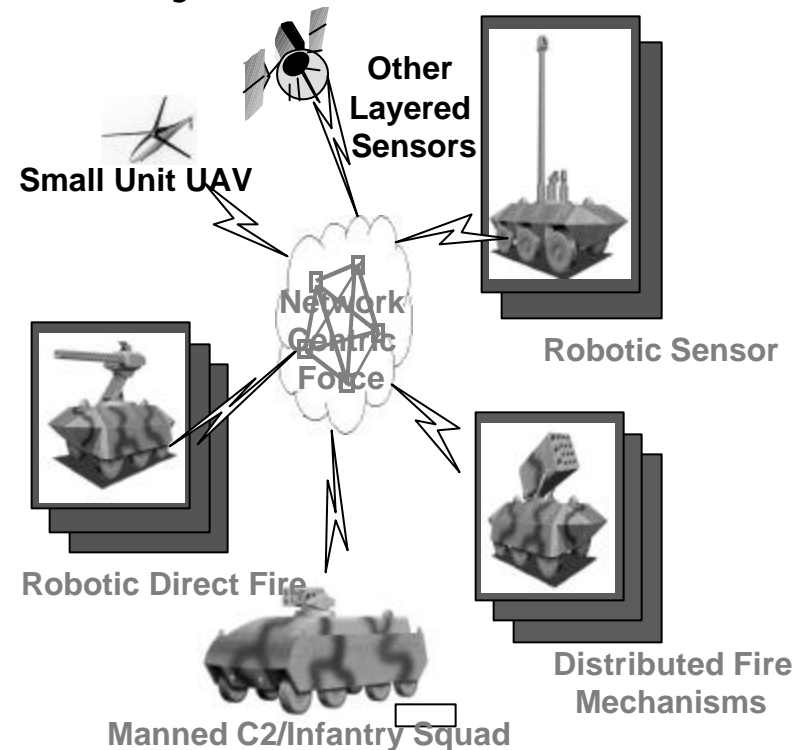
- Increased force effectiveness and survivability
- Increased freedom of maneuver – fewer operational risks

Robots out front - leading the way - in harm's way – increasing force effectiveness



Building the foundation for future ground robotic systems

- Perception
- Intelligent control
- Tactical behaviors
- C2 for mixed forces



- Negotiate complex terrain at tactical speeds
- Complete terrain understanding to support tactical behaviors
- Increased autonomy based upon commander's intent
- Adaptive reasoning based upon mission, terrain, opponents, and friendly forces